Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 Certificate

Tuesday 4 June 2024

Afternoon (Time: 1 hour 40 minutes)

Paper reference **7MC0/01**

Mathematics in Context

PAPER 1: Comprehension

You must have: Ruler graduated in centimetres and millimetres, pen, HB pencil, eraser, calculator.
Source booklet (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- **Calculators may be used.**

Information

- The total mark for this paper is 60
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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SECTION A

Answer ALL questions. Write your answers in the spaces provided.

BEES

Refer to **data source A** in the source booklet for Question 1.

1 Use the information in data source A to

(a) (i) calculate the decrease in the number of honey-producing bee colonies from 1968 to 2019.

(1)

(ii) work out the percentage decrease in the number of honey-producing bee colonies from 1968 to 2019.

(2)

(b) In which time period was the number of honey-producing bee colonies most stable? Give a reason for your answer.

(2)

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(c) Calculate the number of Asian giant hornets it would take to destroy a bee colony, of average size, in 90 minutes.

(3)

(Total for Question 1 is 8 marks)

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Refer to **data source B** in the source booklet for Question 2.

2 The table shows information about the percentage of managed honey bee colonies lost in 42 US states during winter 2020/2021.

Percentage of colonies lost (p%)	**Number of states**				
$20 < p \leqslant 30$	9				
$30 < p \leqslant 40$	16				
$40 < p \leqslant 50$	14				
$50 < p \leqslant 60$	3				
Total	42				

(a) Calculate an estimate for the standard deviation of the percentage of colonies lost during the winter 2020/2021.
Give your answer correct to 1 decimal place.

(4)

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An estimate of the mean percentage of colonies lost in these 42 states during winter 2020/2021 is 37.6%

The table shows information about the percentage of colonies lost in these 42 states during summer 2020.

Mean	24.7%
Standard deviation	12.3%

(b) Compare, in context, the percentage of colonies lost during winter 2020/2021 with the percentage of colonies lost during summer 2020 in these 42 states.

(2)

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(Total for Question 2 is 6 marks)

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Refer to **data source C** in the source booklet for Questions 3, 4 and 5.

3 (a) Show that, in 2021, the value of annual US production of bee-pollinated products was less than 10% of the value of worldwide bee-pollinated products.

(1)

(b) Calculate the pollination income in 2020.
Give your answer correct to the nearest million.

(3)

(Total for Question 3 is 4 marks)

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4 A spreadsheet can be used to calculate the 3-point moving averages for the information in **Table 2** in the source booklet.

	A	B	C
1	**Year**	**Honey yield per colony (pounds)**	**3-point moving average (correct to 2 dp)**
2	2010	65.6	
3	2011	59.6	60.43
4	2012	56.1	57.43
5	2013	56.6	59.27
6	2014	65.1	60.20
7	2015	58.9	60.77
8	2016	58.3	57.50
9	2017	55.3	56.00
10	2018	54.4	55.17
11	2019	55.8	54.90
12	2020	54.5	
13	2021	46.9	

(a) Write down a suitable formula for cell C12

(2)

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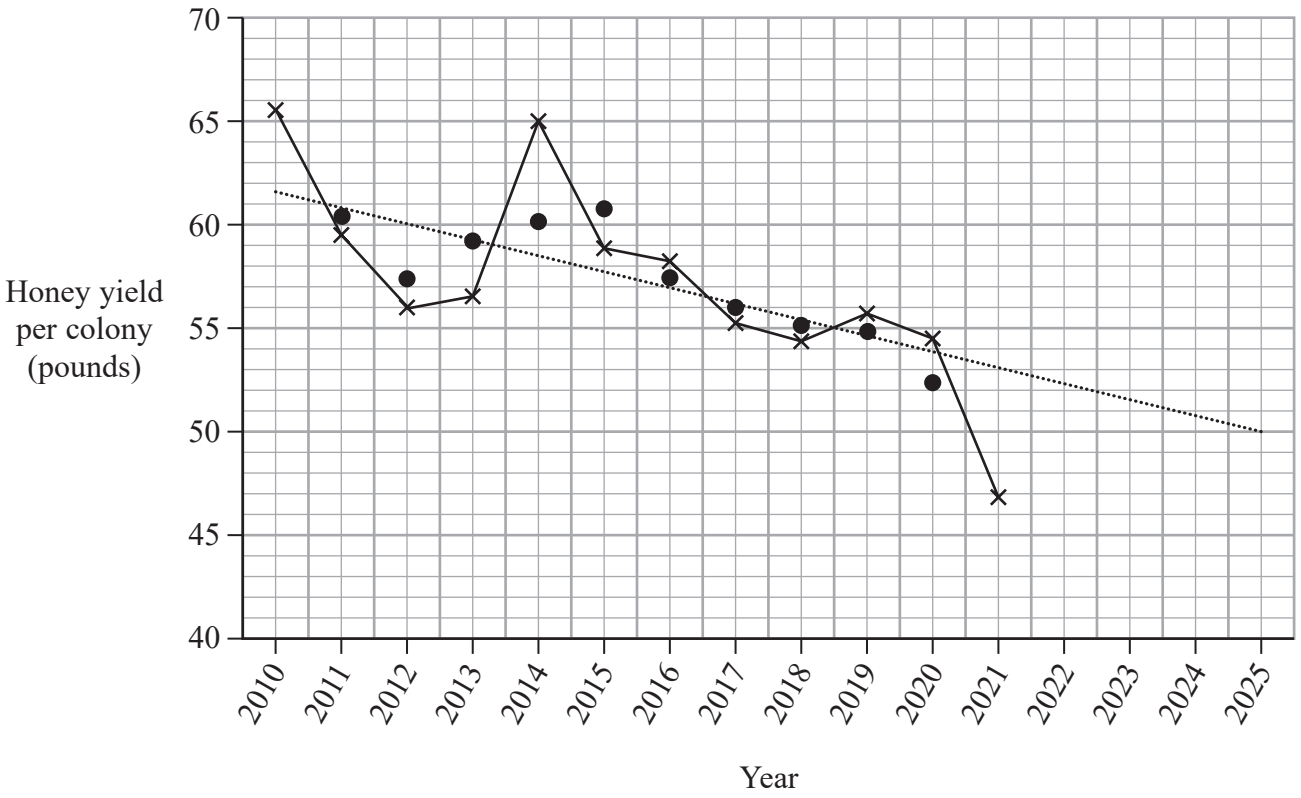
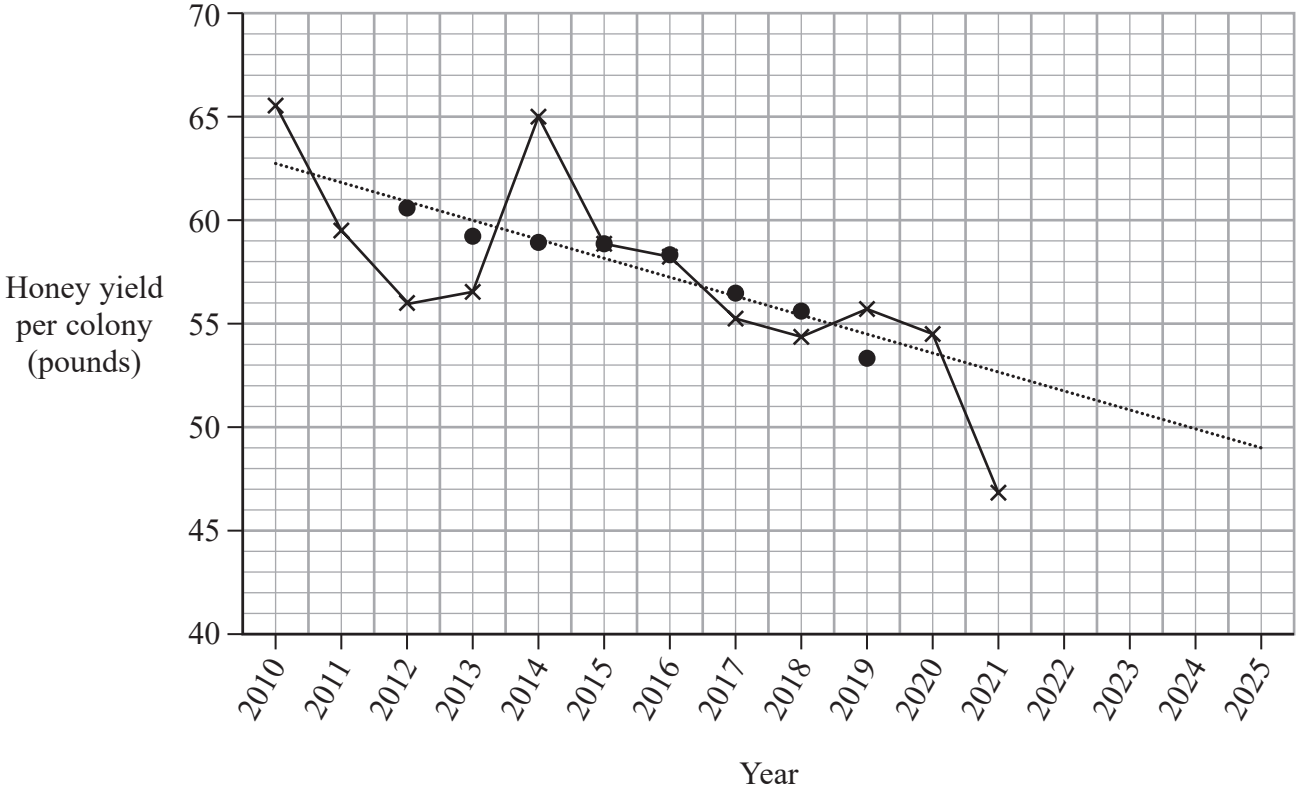
The graphs below show the honey yields, the 3-point moving average, the 5-point moving average and the trend lines per colony for 2010 to 2021.

3-point moving average



5-point moving average



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A beekeeper thinks using the 5-point moving average graph to predict the expected honey yield per colony for the next 5 years is more reliable than using the 3-point moving average graph.

(b) (i) Is the beekeeper correct?
Give a reason for your answer.

(1)

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(ii) Use the 5-point moving average graph to predict the honey yield per colony in pounds for the year 2024.

(1)

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(Total for Question 4 is 4 marks)

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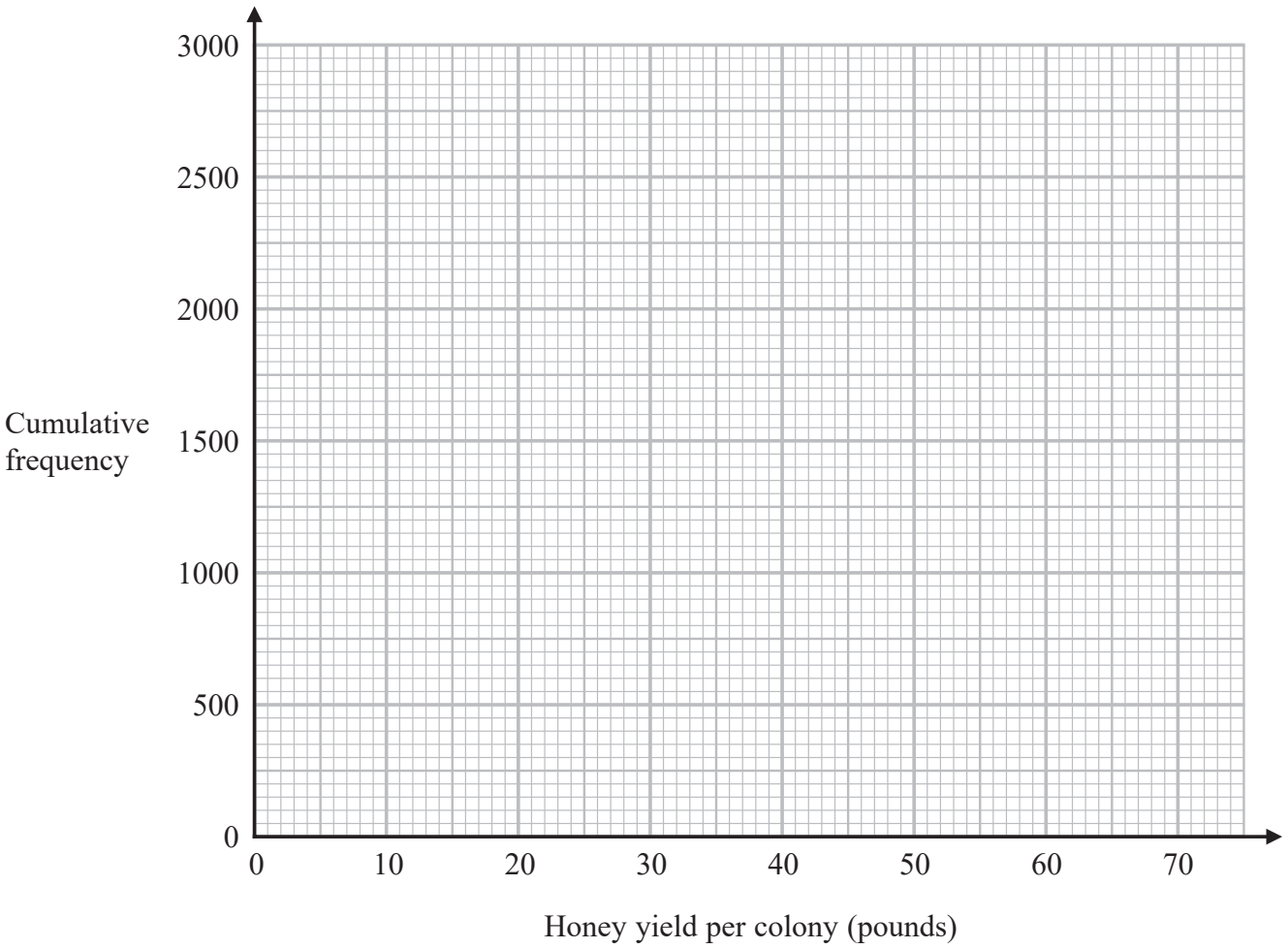
5 The average honey yield per managed colony in 2021, as shown in **Table 3** in the source booklet, is summarised in the cumulative frequency table below.

Average honey yield per colony (pounds)	Cumulative frequency
$20 < p \leqslant 30$	100
$20 < p \leqslant 40$	800
$20 < p \leqslant 50$	1450
$20 < p \leqslant 60$	2650
$20 < p \leqslant 70$	2700

(a) On the grid, draw a cumulative frequency graph for this information.

(2)



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A colony is considered healthy if the honey yield is greater than 43 pounds.

(b) Estimate the percentage of colonies in 2021 that would be considered healthy.

(3)

Reggie is a beekeeper.
He sells the honey produced by his colonies.

Reggie uses the median honey yield per colony to estimate the income per colony in 2021.
He earns \$2.54 for each pound of honey produced.

In 2020, Reggie earned \$110.63 for the honey yield per colony.

Reggie thinks he earns \$20 more for the honey yield per colony in 2021 than in 2020.

(c) Is Reggie correct?
Use your graph in part (a) to justify your answer.

(3)

(Total for Question 5 is 8 marks)
(Total for BEES is 30 marks)

TOTAL FOR SECTION A IS 30 MARKS

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SECTION B

Answer ALL questions. Write your answers in the spaces provided.

RETAIL INDUSTRY

Refer to **data source D** in the source booklet for Question 6.

6 (a) (i) Show that the mean number of stores closing each day in 2021 is 47 correct to the nearest whole number.

(1)

An article claims that, between 2016 and 2021, the rate at which retail chains are closing stores is greater than the rate at which retail chains are opening new stores.

(ii) Explain how **Figure 2** in the source booklet supports this claim.

(1)

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In 2021 there were

7160 retail chain store openings
17219 retail chain store closures.

An article claims that for these store openings and store closures, online shopping in 2020/2021 has affected the high street more than retail parks.

(b) Using these values and **Figure 3** in the source booklet, compare the proportion of store openings and the proportion of store closures in these locations to evaluate this claim.

(3)

(Total for Question 6 is 5 marks)

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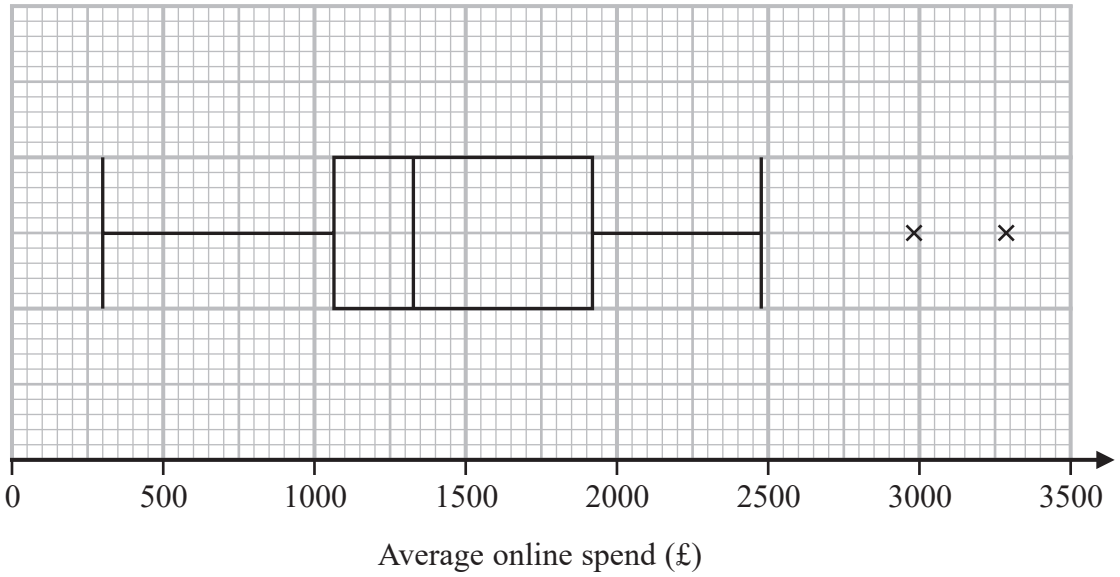
Refer to **data source E** in the source booklet for Questions 7 and 8.

7 The data for the average online spend in 2021, from **Table 4** in the source booklet, is summarised in the box plot below.



(a) Describe the statistical meaning of the two crosses shown on the diagram above.

(1)

(b) Use the box plot to find an estimate for the interquartile range for this data.

(2)

(Total for Question 7 is 3 marks)

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8 Using the data from **Table 5** in the source booklet, the equation of the regression line of y on x between 2010 and 2019 is

$$y = a + bx$$

where

x is the year
y is the online sales revenue as a percentage of the total retail sales revenue.

Given that,

$S_{xy} = 110.4$
$S_{xx} = 82.5$
$S_{yy} = 150.14$
$\sum x = 20\ 145$
$\sum y = 128$

(a) show that,

$a = -2687$ correct to the nearest whole number
$b = 1.34$ correct to 2 decimal places.

(4)

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Let P be the expected online sales revenue as a percentage of the total retail sales revenue.

P can be calculated by either using

$y = 1.34x - 2687$ based on data from 2010 to 2019

or

$y = 1.85x - 3710$ based on data from 2010 to 2021.

The table shows some values of P found by using these equations.

Year	Actual percentage	P using $y = 1.34x - 2687$	P using $y = 1.85x - 3710$
2010	7.4	6.4	8.5
2011	8.5	7.7	10.4
2012	9.5	9.1	12.2
2013	10.3	10.4	14.1
2014	11.2	11.8	15.9
2015	12.8	13.1	17.8
2016	14.9	14.4	19.6
2017	16.5	15.8	21.5
2018	17.8	17.1	23.3
2019	19.1	18.5	25.2
2020	24.7		27.0
2021	31.02		…….

(b) Calculate P for 2021 using $y = 1.85x - 3710$

(2)

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(c) Comment on the suitability of using linear regression to make predictions for P in 2020 and 2021.
Use figures to support your answer.

(1)

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(Total for Question 8 is 7 marks)

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Refer to **data source F** in the source booklet for Questions 9 and 10.

9 The table below shows the data from **Table 6** in the source booklet ranked by sales revenue.

Store type	Sales revenue ($1 000 000 000)	Advertising spend ($1 000 000)		
Hobby, toy and games	5.9	180		
Computer	6.0	90		
Furniture	6.1	190		
Jewellery	8.1	530		
Shoe	16.9	460		
Women's clothing	17.2	600		
Home furnishings	20.2	1100		
DIY	33.2	420		
Electronics	53.4	1010		
Department	59.8	2150		
Family clothing	117.6	2920		
Health and beauty	456.2	1200		

(i) Calculate Spearman's rank correlation coefficient for the data in the table.

(6)

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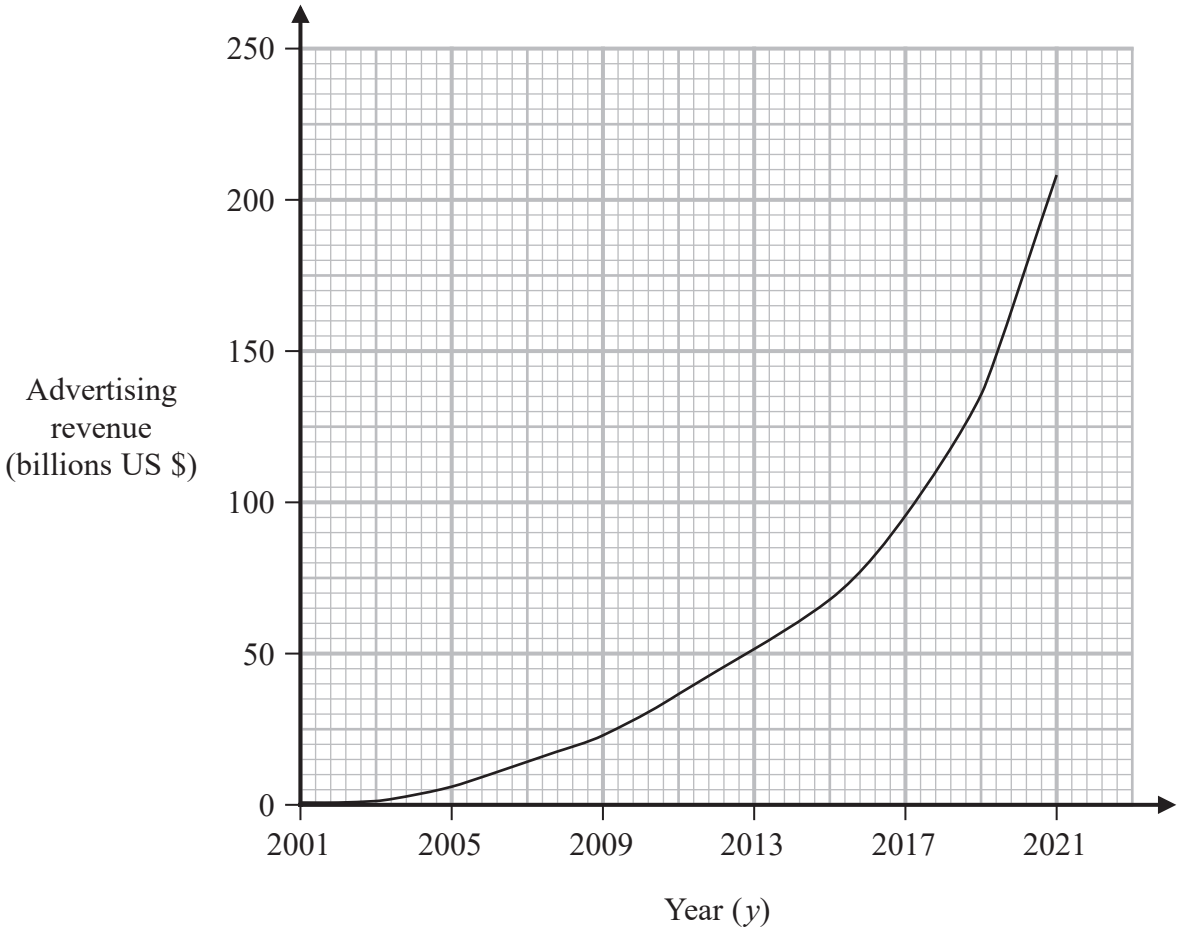
Florence thinks that store types that spend more money on advertising will usually have a greater sales revenue.

(ii) Is Florence correct?
Use part (i) to justify your answer.

(1)

(Total for Question 9 is 7 marks)

10 The graph below shows a model **fitted** to the data shown in **Figure 4** in the source booklet.



(a) What type of function would best represent this model?

(1)

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(b) (i) Work out an estimate of the gradient of the graph at $y = 2015$
You must show all your working.

(3)

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(ii) Explain, in context, what this gradient represents.

(1)

The compound annual growth, G_n, is a value that describes the rate at which an investment would have grown for n years if it had grown at the same rate every year.

The compound annual growth rate per year since 2001, G_n, can be calculated using

$$G_n = \left[\left(\frac{r}{b}\right)^{\frac{1}{n-2001}} - 1\right] \times 100$$

where

b is the advertising revenue, in billions US$, in 2001
r is the advertising revenue, in billions US$, in the end year
n is the end year.

(c) Calculate the compound annual growth rate for the information from **Figure 4** in the source booklet between 2001 and 2021.

(3)

(Total for Question 10 is 8 marks)
(Total for RETAIL INDUSTRY is 30 marks)

TOTAL FOR SECTION B IS 30 MARKS
TOTAL FOR PAPER IS 60 MARKS

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Pearson Edexcel Level 3 Certificate

Tuesday 4 June 2024

Afternoon (Time: 1 hour 40 minutes)

Paper reference **7MC0/01**

Mathematics in Context

PAPER 1: Comprehension

Source Booklet

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Formulae sheet

There will be no credit for anything you write on this formulae sheet.

Mean of a frequency distribution $= \dfrac{\sum fx}{\sum f}$

Mean of a grouped frequency distribution $= \dfrac{\sum fx}{\sum f}$, where x is the mid-interval value

Variance $= \dfrac{\sum (x - \bar{x})^2}{n}$

Standard deviation (set of numbers) $\sqrt{\left[\dfrac{\sum x^2}{n} - \left(\dfrac{\sum x}{n}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum (x - \bar{x})^2}{n}\right]}$

where $\bar{x}$ is the mean of the set of values

Standard deviation
(discrete frequency distribution) $\sqrt{\left[\dfrac{\sum fx^2}{\sum f} - \left(\dfrac{\sum fx}{\sum f}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum f(x - \bar{x})^2}{\sum f}\right]}$

Spearman's rank correlation coefficient $1 - \dfrac{6\sum d^2}{n(n^2 - 1)}$

The product moment correlation coefficient is

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}} = \frac{\sum x_i y_i - \frac{\left(\sum x_i\right)\left(\sum y_i\right)}{n}}{\sqrt{\left(\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n}\right)\left(\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n}\right)}}$$

The regression coefficient of y on x is $b = \frac{S_{xy}}{S_{xx}}$

Least squares regression line of y on x is $y = a + bx$ where $a = \bar{y} - b\bar{x}$

Arithmetic series

$$u_n = a + (n - 1)d$$

$$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n[2a + (n - 1)d]$$

Geometric series

$$u_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r}$$

$$S_\infty = \frac{a}{1 - r} \text{ for } |r| < 1$$

There will be no credit for anything you write in this source booklet.

SECTION A: BEES

Data source A

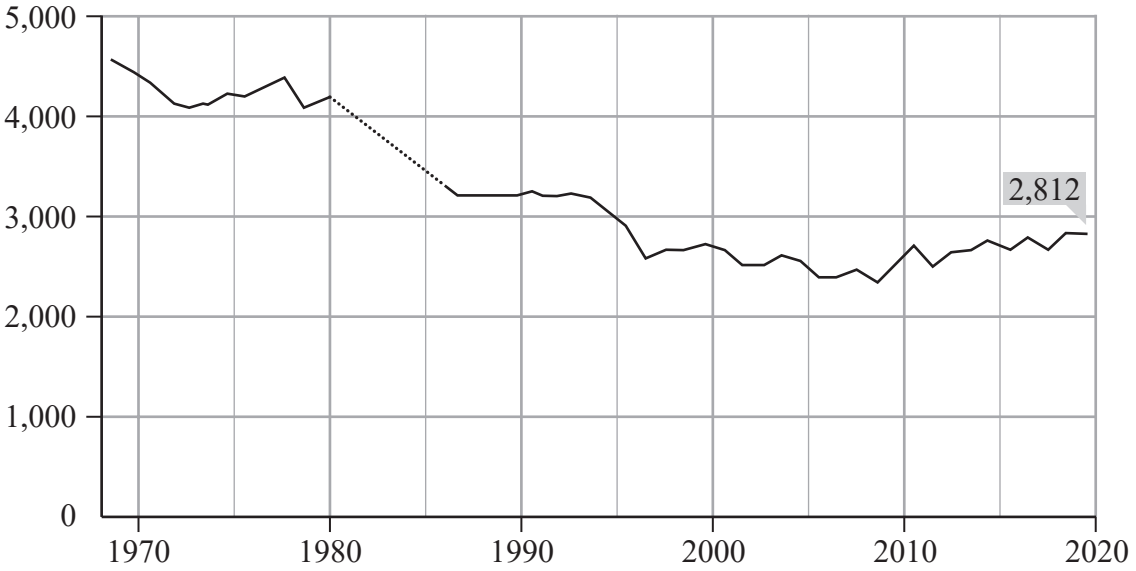
Will The Murder Hornet Accelerate the Honey Bee's Decline?

The Asian giant hornet, also known as the "murder hornet", has arrived in the United States. Nearly two inches long, the species is the world's largest wasp and it has been observed in Washington State.

The honey bee population is already in decline as the infographic below illustrates. Back in 1968, there were 4.5 million honey-producing bee colonies and that declined to around 2.8 million in 2019 (no data was recorded in the period from 1980 to 1985).

The Asian giant hornet is a voracious predator and a large group of them can destroy an entire colony of native honey bees, with an average size of 60 000, in just 90 minutes. Just one hornet can kill 40 bees per minute. If the spread is not contained, there are serious fears that the invaders will decimate America's pollinators.

Figure 1: Number of honey-producing bee colonies in the US, in thousands, by year from 1968 to 2019



No data on colony numbers were recorded for 1980-1985.

Data source B

The Bee Informed Partnership (https://beeinformed.org) is a non-profit organisation that works alongside beekeepers to improve honey bee colony health and survivorship across the United States. One of the organisation's longest running programs, the National Colony Loss and Management Survey was initiated in 2007. Since then, it has monitored managed honey bee colony loss rates, and identified risk factors and protective measures associated with beekeeping management.

A total of 3,347 beekeepers from the United States that collectively managed 192,384 colonies on 1 October 2020 provided validated survey responses. This represented 7% of the estimated 2.71 million managed honey-producing colonies in the country in 2020 (USDA NASS, 2021).

Every year, participants are asked to report what level of winter loss they would consider acceptable. The October 2020 survey concluded that a winter loss of 23.3% was an acceptable level.

Some states did not contribute to the survey.

Table 1: Summary of the percentage of managed bee colonies lost in 42 US states during winter 2020/2021

Percentage of colonies lost (p%)	Number of states
$20 < p \leqslant 30$	9
$30 < p \leqslant 40$	16
$40 < p \leqslant 50$	14
$50 < p \leqslant 60$	3
Total	42

Data source C

Managed honey bees are the most valuable pollinators and are an essential link in agriculture. Animal pollinators, especially bees, are critical for producing more than one-third of US food products. In fact, bee-pollinated products account for $20 billion in annual US production and $217 billion worldwide in 2021.

Managed bee colonies are transported to help pollinate crops around the US and the by-product of honey adds value and worth to beekeepers. Pollination income for 2021 was $269 million, up 6% from 2020. Other income from honey bees in 2021 was $102 million, up 82% from 2020.

Table 2: Total number of managed bee colonies and honey yield per colony for 42 US states 2010 to 2021

Year	Number of managed honey producing colonies (thousands)	Honey yield per colony (pounds)
2010	2692	65.6
2011	2491	59.6
2012	2624	56.1
2013	2640	56.6
2014	2740	65.1
2015	2660	58.9
2016	2775	58.3
2017	2669	55.3
2018	2803	54.4
2019	2812	55.8
2020	2706	54.5
2021	2696	46.9

Table 3: Summary of the average honey yield per managed colony for a sample of 2700 colonies in the US in 2021

Honey yield per colony (pounds)	Number of colonies
$20 < p \leqslant 30$	100
$30 < p \leqslant 40$	700
$40 < p \leqslant 50$	650
$50 < p \leqslant 60$	1200
$60 < p \leqslant 70$	50

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Please turn over for source data for Section B.

SECTION B: RETAIL INDUSTRY

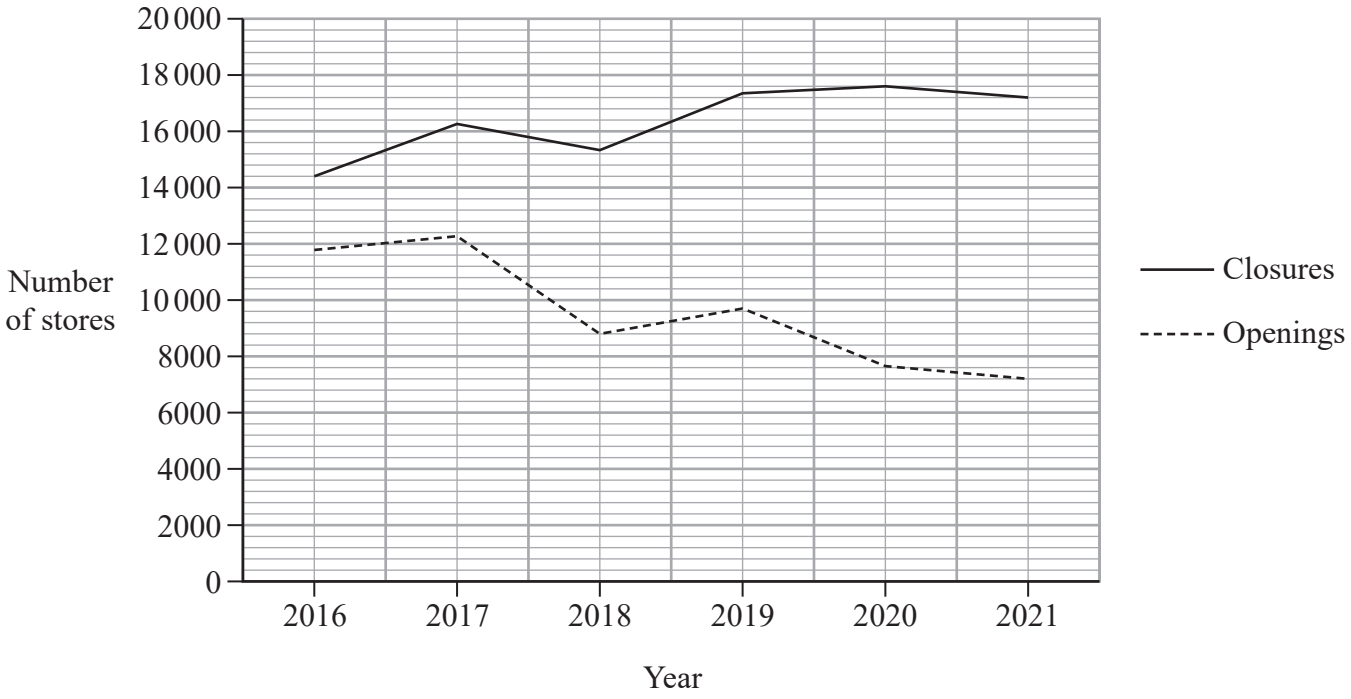
Data source D

More than 17 000 chain store shops closed last year

More than 17 000 chain store outlets closed across Britain in 2021, according to new research.
The figures, compiled for the accountancy firm PwC, reflect the rise of online shopping.
However, the data suggests the rate of closures is slowing as more independent firms take on space.
"The worst could now be over," said the head of consumer markets at PwC.

As the chart below shows, there was a slight reduction in the number of chain store closures last year, with 17 219 stores closing in 2021.
But there was also another sharp drop in the number of openings, with 7160 stores opening in 2021, which led to a net loss of 10 059 outlets, the biggest fall since 2014.

Figure 2: Chain store openings and closures 2016 to 2021



The need for more online shopping has accelerated the changes already under way across retail, causing upheaval for many high streets and town centres.
It's not the death of the high street but rather a final shake-out of some of the heritage brands.

Meanwhile, some locations continue to do better than others.
Yet again, retail parks, clusters of large stores often on the edge of town, have proved to be the most resilient.
They've become more popular with shoppers recently thanks to easier access and parking. In contrast, shopping centres have gone from being the most popular retail locations in 2015 to the worst performing over the last two years.

Figure 3: Total number of chain store openings and closures in 2021 by location

Multiple retailers/chains with more than five outlets

(Source: PwC data compiled by Local Data Company for 2021 across GB. BBC)

Data source E

Table 4: Mean average amount spent per person online buying goods for 19 European countries (nearest whole £) in 2021

Country	Average online spend (£)
Austria	1629
Belgium	1335
Czech Republic	649
Denmark	2981
Finland	2370
France	1567
Germany	1332
Greece	1061
Hungary	383
Italy	1102
Netherlands	1532
Norway	2488
Poland	471
Portugal	1135
Slovakia	300
Spain	1056
Sweden	1382
Switzerland	1915
UK	3297

Table 5: Online sales revenue as a percentage of total retail sales revenue for the UK 2010 to 2021

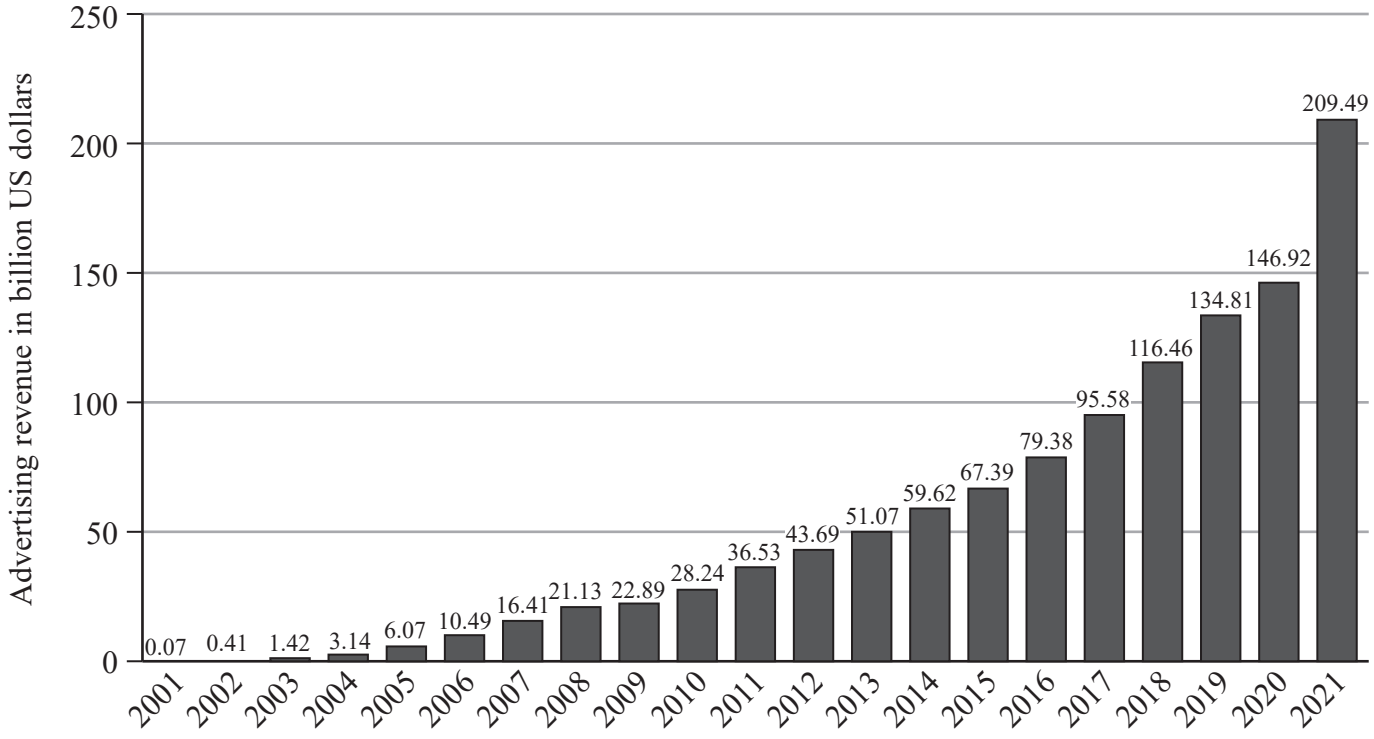
Year	Actual percentage
2010	7.4
2011	8.5
2012	9.5
2013	10.3
2014	11.2
2015	12.8
2016	14.9
2017	16.5
2018	17.8
2019	19.1
2020	24.7
2021	31.02

Data source F

Table 6: Sales revenue and advertising spend for different store types in 2021

Store type	Sales revenue ($1 000 000 000)	Advertising spend ($1 000 000)
Hobby, toy and games	5.9	180
Computer	6.0	90
Furniture	6.1	190
Jewellery	8.1	530
Shoe	16.9	460
Women's clothing	17.2	600
Home furnishings	20.2	1100
DIY	33.2	420
Electronics	53.4	1010
Department	59.8	2150
Family clothing	117.6	2920
Health and beauty	456.2	1200

Figure 4: Google's advertising revenue from 2001 to 2021



Source information

Data source A adapted from:
https://www.statista.com/chart/21600/honey-producing-bee-colonies-in-the-us/

Data source B adapted from:
https://beeinformed.org/2021/06/21/united-states-honey-bee-colony-losses-2020-2021-preliminary-results/

Data source C adapted from:
https://www.statista.com/statistics/593611/us-average-prices-honey/
https://www.beeculture.com/u-s-honey-industry-report-2021/

Data source D adapted from:
https://www.bbc.co.uk/news/business-60418435
https://www.pwc.co.uk/press-room/press-releases/store-openings-and-closures.html

Data source E adapted from:
https://merchantmachine.co.uk/cyber-shopping/
https://www.statista.com/statistics/825461/proportion-of-retail-sales-made-online-great-britain-total/

Data source F adapted from:
http://www.rab.com/research/10014.pdf
https://www.statista.com/statistics/266249/advertising-revenue-of-google/